

AN INVESTIGATION INTO THE ECOLOGY AND PRODUCTIVITY OF EPIPHYTIC MOSSES

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ABSTRACT

Experimental harvesting of moss was undertaken for five years at two Transvaal localities. Determination of productivity was the main aim. It was established that mosses are very slow growing and require a minimum of seven to 10 years after harvesting to regenerate. Annual production amounted to 4 700 g/ha which is only 7,64 % regrowth, while biennial plots exhibited 15,45 % regrowth and triannual plots produced 27,38 % of the initial harvest. As Transvaal only has approximately 15 959 hectares of harvestable moss (5 426 002 kg), which on a sustained yield basis can be divided into 2 279,83 ha yielding 775 143 kg moss/annum on a seven year basis while over 10 years, 1 595,88 ha could be harvested with a sustained yield of 542 600 kg/annum.

UITTREKSEL

'N ONDERSOEK NA DIE EKOLOGIE EN PRODUKTIWITEIT VAN EPIFITIESE MOSSE

Eksperimentele versameling van mos is vir vyf jaar by twee Transvaalse lokaliteite gedoen. 'n Bepaling van die produktiwiteit was die hoofdoel. Daar is vasgestel dat mosse baie stadig groei en 'n minimum van tussen 7 en 10 jaar na dit geoes is, word benodig om te herstel. Die jaarlikse produksie was 4 700 g/ha wat slegs 'n 7,64 % herstel verteenwoordig terwyl persele wat elke tweede jaar geoes is 'n herstel van 15,45 % en persele wat na drie jaar geoes is 27,38 % van die oorspronklike oes gelewer het. Aangesien Transvaal net sowat 15 959 ha oesbare mos het (5 426 002 kg), kan dit teen 'n volgehoue basis in 2 279,83 ha gedeel word om 775 143 kg mos/jaar te lewer op 'n sewejaar basis terwyl daar oor 10 jaar van 1 595,88 ha 'n volgehoue produksie van 542 600 kg/jaar geoes kan word.

INTRODUCTION

On account of their water holding capacity epiphytic mosses are widely utilised by florists to pack flowers for shipment, for floral arrangements and for exhibition purposes. This has resulted in a demand for moss, that is harvested by Bantu gatherers and sold to the florists. The moss is harvested in the indigenous forests of the Transvaal, mainly in the east, along the Transvaal Drakensberg but also in the Soutpansberg. As these areas are the main source of moss in the Transvaal and because of the limited area covered by indigenous forest, the supply of moss is likewise limited. In addition, as large areas of forest lie in Bantu homelands, the protection afforded them by the Department of Forestry falls away and these areas are being severely cut back by indiscriminate woodcutting, burning and the foraging of livestock.

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In view of these limitations in the supply of moss, the harvesting on a large scale was considered with concern by the Division of Nature Conservation and mosses were placed on the list of Transvaal Protected Plants. The demand of the florists was however not ignored and an investigation into the ecology and production of mosses was initiated by Mr J. Jooste of the Division of Nature Conservation to determine the effects of harvesting, so that effective management, with the object of a sustained yield could be instituted. Adequate permits could then be issued to avoid over-exploitation. The aims of the project were therefore essentially threefold:

- (a) Determination of the amount of epiphytic mosses in the indigenous montane forests of the Transvaal.
- (b) Determination of the time it takes for the moss to regenerate fully after harvesting.
- (c) Determine the areal percentage which can be annually harvested on a sustained yield basis.

METHODS

For a determination of the total amount of harvestable moss it was necessary firstly to establish the total area in which moss occurs. Areas of indigenous forest were calculated from existing maps and aerial photographs with the aid of a planimeter, after local inspection to check on the distribution of moss.

In two areas, namely Woodbush and the farm Bloemfontein in the Soutpansberg, plots 100 square metres in extent were laid out. In the former a series of five plots was set out initially in June 1970, of which one (E) could not be re-located a month later (Jooste, 1971). This was followed by another set of 10 plots during July, 1972. The former set was used for annual growth checks, while five of the latter were used for biennial checks and the remaining five for triannual checks on regeneration. At Bloemfontein a set of five plots was set out and harvested annually during January.

The plots were laid out in various sections of the forests so as to cover a variety of microclimates ranging from dry to wet. The selection of plots was arbitrary and their suitability visually estimated. Each plot was beacons off with numbered wood or iron poles at the corners.

During 1972 all the plots at Woodbush were subdivided into quarters, (subplots), in order to establish whether any variations existed within each plot as a result of climatic or other local factors.

To determine the surface area, the trees within the plots were measured to an arbitrary height of two metres, based on the assumption that the Bantu gatherers did not harvest beyond that point. The circumference of the trees was measured at one metre from base and multiplied by the arbitrary height thus giving the area of the tree trunk. In cases where the trees had large buttress roots measurements were taken from where the trunk became vertical.

The moss was harvested by hand, placed in plastic bags and then sorted to remove foreign material such as pieces of bark and soil. It was then transferred into paper bags, oven dried over a period of 24 hours at 85 °C (185 °F) and weighed.

The average weight of moss per plot (100 m²) was used to calculate the amount of harvestable moss available.

For a determination of the time taken for moss to regenerate completely the plots were visited and harvested annually. The two and three year plots at Woodbush were harvested during 1974 and 1975 respectively. It must be stressed here that harvesting during experimentation was more severe than that of the Bantu gatherers who removed only the moss which was readily available.

RESULTS

Area determination

In the area calculations allowances were made for roads and open areas. These calculated areas are set out in Table 1. Excluded are the indigenous forests on the farm Bloemfontein in the Soutpansberg, in the Blyde River Canyon and in the Sabi area. The tabulation, however, contains the major areas of forest which were investigated.

TABLE 1.

Surface area of indigenous forest and surface covered by moss in the various plantations.

Area	Total area of indigenous forest (hectares)	Area in which moss is found (hectares)
Hanglip	206,78	190,20
Woodbush	4 271,50	3 630,76
De Hoek	2 355,43	2 143,46
Mariepskop	3 039,35	2 811,39
Entabeni	1 711,38	1 608,67
Salique	2 819,04	2 678,09
New Agatha	2 197,24	2 087,37
Roodewal/Goedehoop	337,22	320,35
N. Tvl. S.A.B.T.	463,45	444,91
Nieshoutsfontein LS 957	43,63	43,63
TOTAL	17 444,02	15 958,83

In the Bantu homeland area of the Soutpansberg only the farm Bloemfontein was found to have moss in harvestable quantities. The area of indigenous forest does not cover more than about 300 hectares, parts of which are rapidly being destroyed so that this area can probably be ruled out as a future source, especially as illegal harvesting of moss is adding to a swift deprivation (P. W. de Wet Wessels, pers. comm.)

The total area of indigenous forest in the Transvaal with the exception of small areas scattered in the east and north east is thus 17 444 hectares, of which 91,49 % or 15 959 hectares contain epiphytic mosses. This is only 0,06 % of the total land area of the Transvaal which fortunately, however, falls mainly under the Department of Forestry and is thus afforded some protection.

Regeneration Period

The moss is harvested manually by the Bantu gatherers to a height of two metres. Experimental harvesting extended over the six year period 1970–1975, though only for five years on the farm Bloemfontein, while at Woodbush the year 1971 was excluded as the initiator of the Project left the Division and the author continued with the Project only in 1972. Annual harvesting therefore took place at both sites for four consecutive years. Unfortunately the first year of reharvesting resulted in some discrepancies as may be seen on Table 2. This may be due to varying sampling techniques as it was not always possible to recognize which trees had previously been harvested, the present author not having accompanied the initial researcher during his visits, so that perhaps different standards were used in determining the extent of harvesting. The greatest discrepancy lies in the method of measuring the surface area, that is circumference and height. The method used by the present author is noted above. When comparing the figures from Bloemfontein it will be noticed that in plot C the difference in surface area between 1971 and 1972 is very great and probably due to measuring error, as it is doubtful that the growth rate on 35 trees would vary to such an extent.

When the present author took over, all the trees within the plots were re-measured and subsequently over the following three years only those trees with harvestable moss were measured so that moss regrowth per unit area could be established and compared. Large differences in the weights of moss per unit surface area such as are exhibited by plots A and C could also be due to the harvesting of certain moss species which were not reaped by the previous worker. As there was no request for species determination, it was thought best to harvest all moss species on the trees within the plots and this procedure was adhered to throughout the duration of the project. No change in species diversity was observed throughout the duration of the study and regeneration was apparent from the moss remnants left behind after the previous harvesting. In some instances young plants were seen germinating in areas which were moister than the surroundings but these seedlings appeared to be the same species as the adults harvested on the same trunks. One of the commoner species involved was *Papillaria natalensis* Sim. Florists utilise the moss irrespective of length or species. The results of the harvesting are shown on Tables 2, 3 and 4 in the Appendix.

From these it is evident that experimental harvesting has a considerable influence on the regeneration of moss. Particularly noteworthy is the reduction in

the number of trees with harvestable moss among the annual plots, both sites showing similar trends in the fluctuations of average numbers of trees per plot per annum. (Table 5(a) and (b)).

TABLE 5.
Fluctuations in average number of trees per plot per annum.

(a) Woodbush

	1972	1973	1974	1975	Total	Ave
A	23	19	17	12	71	17,75
B	30	13	22	14	79	19,75
C	30	9	18	15	72	18,00
D	17	0	9	9	35	8,75
Total	100	41	66	50	257	
Ave	25	10,25	16,5	12,5	64,25	

(b) Bloemfontein

	1972	1973	1974	1975	Total	Ave
A	25	15	21	16	77	19,25
B	27	1	21	11	60	15,00
C	35	0	10	8	53	13,25
D	23	1	NR	NR	24	12,00
E	17	0	0	6	23	5,75
Total	127	17	52	41	237	
Ave	25,4	3,4	13,0	10,25	59,25	

NR = not recorded during 1974-1975

These fluctuations are mainly due to the fact that moss regenerates very slowly, particularly after the first severe harvesting to which it is subjected. Consequently when the sites are re-visited only those trees with moss of harvestable length, that is one centimetre or more, are measured, while those which have moss of only very short growth are left until sufficient re-growth permits harvesting at later visits. The fluctuations are also documented in the graphs (Fig. 1) showing the annual yield of moss per plot. However, an average of the fluctuating yields will give a better picture as to the amount of regenerated moss per year. Over the three years subsequent to 1972 the average yield of moss harvested per plot from Woodbush and Bloemfontein amounts to 47 grams and 45 grams (dry weight) respectively (see Tables 2 and 3). In contrast the biennial plots yielded an average of 69 grams per plot and it is noticeable that only 48,5 % of the trees had harvestable moss after two years. The triannual plots show a substantial increase and an average of 101 grams per plot was harvested. However, only 51 % of the trees were found with harvestable moss representing only a slight increase on the biennial plots and the equal percentage to the average of the annual plots. It, therefore, appears that at Woodbush approximately 50 % of the trees remain barren after being harvested and that the moss requires a longer period to regenerate on them.

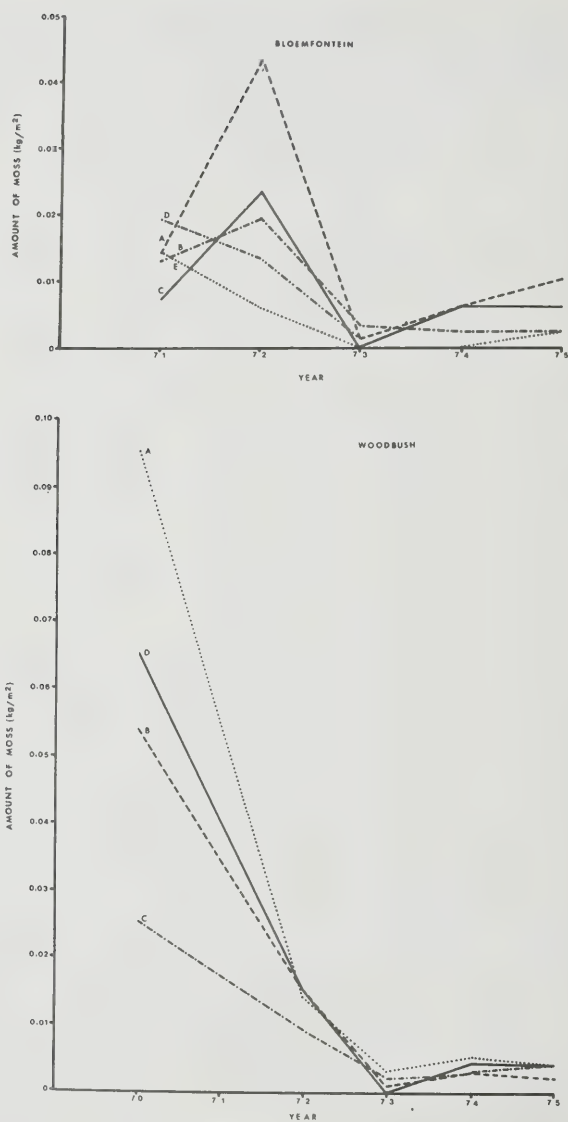


FIG. 1.
Annual fluctuations in the amount of moss harvested.

Factors controlling Re-generation

There are a number of factors which influence the regrowth of moss. Prior to harvesting, the moss hangs festooned from the trunks and branches of the trees as also from rocks in the forest. Moss grows more profusely in a relatively closed canopy forest than in an open forest where penetration by wind and sunlight causes dehydration. The plots laid out in the forest aimed at the investigation of these variations. This is clearly demonstrated at Woodbush when plots A and C are compared, the former giving much larger yields than the latter. A similar variation was observed at Bloemfontein.

Slope aspect appears to influence the growth of moss as it frequently only grows on one side of the trunk, leaving the opposing side bare. This, no doubt, is due to the prevailing weather conditions which bring more moisture to the exposed side of the tree trunk while the other side remains in a partial rain shadow. Higher up the tree the disparity disappears.

At Woodbush the E, SE and S sides of the stems have the most luxurious moss cover. The same applies to younger trees where the bark is usually smoother than in the adult stage and here it needs several years for the moss to establish itself.

Rough bark is more densely moss-covered because its rugosity offers innumerable places for the moss spores to lodge. It also collects falling dust and humus which lodge in the cracks and form a growth medium in which the spores can germinate, enhanced by a higher degree of water retention as compared with smooth bark which dries fairly rapidly after rain. Harvesting moss from the former is more difficult than from the latter as usually only the easily removable portion of the plants is taken, whereas the moss on smooth trees frequently comes away entirely with stolons and rootlets so that nothing is left for regeneration. Doubtlessly this has a great influence on the assessment of the number of trees with harvestable moss.

Areas in which the undergrowth is relatively dense also appear to produce more moss due to protection from wind and sunlight, while transpiration by the shrubs and herbs also contributes to a moister microclimate. This was seen at Woodbush where moss growing on tree trunks in the herbaceous layer was longer than that on the same tree trunk in a more exposed position.

The influence of Moisture

There does not appear to be a well defined correlation between the amount of moss production and rainfall, but it is felt that this is the case between the growth of moss and the number of misty days per annum. This view is supported by the fact that the average amount of growth of moss per plot at Woodbush and Bloemfontein is very similar although the average rainfall at Woodbush over the four year period 1969 to 1972 is 2.5 times as much as that at Bloemfontein. Taking the three most favourable plots at Woodbush and Bloemfontein, a marked similarity in the amount of regrowth of the epiphytic mosses is revealed.

Experiments undertaken by R. Marloth (Wellington, 1955) on top of Table Mountain showed that during a period of 21 days, the rainfall gauge registered nil whereas a gauge adapted to condense moisture from mist recorded 758,4 mm. On a previous occasion (January-March 1904) the rain gauge also recorded nil whereas the mist gauge registered 484,4 mm. This stresses the importance of mist as a source of moisture especially as it occurs throughout the year in the areas where moss grows. Condensation occurring on the leaves and boles of trees runs down the trunks providing a direct water supply to the moss, besides a certain amount of moisture from the mist which may be absorbed directly. This process was noticed on the Downs in the eastern Transvaal Drakensberg where water was seen streaming down the boles of the trees. Unfortunately there is no record of the number of misty days per annum at either site, so that a numerical correlation is not possible.

Both areas have a similar rainfall pattern with a pronounced peak during the four months December, January, February and March (Table 6). Although on the average rainfalls occur throughout the year there is a distinct minimum during the winter months. Bloemfontein is more arid than Woodbush and usually experiences at least one month without rainfalls. During this period (usually July) the moss becomes dry and brittle but greens up and starts growing during August at Woodbush. There is a great fluctuation in the amount of rain from year to year, being in some years two to three times as much as in other years (Table 6). In these mountainous areas it often rains for days on end with as much as three weeks of cloudy rainy weather, while on the other hand thunderstorms of short duration but intense rainfall occur.

Evaluation of Results

The results reveal that the initial annual harvesting yielded 0,034 kg/square metre. This dropped radically (see Fig. 1) after the initial harvesting and the average annual growth of moss on the plots yielded 0,002 kg/sq. metre (7,6%). In contrast the biennial plots yielded 0,11 kg/sq. m on the initial harvest, but two years later only 0,017 kg/sq. metre (15,45%) had re-grown, which is just over twice the productivity of the annual plots. The triannual plots, which when first harvested yielded 0,029 kg/sq. metre, gave at the second harvest only 0,008 kg/sq. metre (27,5%). This is 3,62 times as much as that of the annual plots and 1,77 times as much as the biennial plots calculated on a percentage basis. At this growth rate the moss would take a minimum of seven years to reach the initial amount harvested and may even take up to 10 years.

The layout of the experimental plots lends itself to statistical analysis by means of a randomised complete block design. The data from the annually harvested plots (1972, 1973 and 1974) were analysed separately from those harvested biennially (1972 and 1974) and triannually (1972 and 1975) (see Tables 7, 8 and 9).

TABLE 7.

Analysis of variance of moss weights (kg per 10×10 m plot) collected annually in 1972, 1973 and 1974.

Source of variation	Sum of squares	Degrees of freedom	Mean Square	F
Plots	0,008819	3	0,002940	2,63
Subplots	0,050897	36	0,001414	1,27
Years	0,046448	2	0,023224	20,81*
Error	0,006693	6	0,001116	
TOTAL	0,1222857	47		

*Significant at 1 % level.

TABLE 8.

Analysis of variance of moss weight (kg per 10×10 m plot) collected biennially in 1972 and 1974.

Source of variation	Sum of squares	Degrees of freedom	Mean Square	F
Plots	0,029397	4	0,0007349	1,20
Subplots	0,238244	30	0,007941	1,30
Years	0,197543	1	0,197543	32,25*
Error	0,024501	4	0,006125	
TOTAL	0,489685	39		

*Significant at 1 % level.

TABLE 9.

Analysis of variance of moss weight (grams per 10×10 m plot) collected triannually in 1972 and 1975.

Source of variation	Sum of squares	Degrees of freedom	Mean Square	F
Plots	325,0	4	81,25	0,78
Years	1 210,0	1	1 210,00	11,72*
Error	413,0	4	103,25	

*Significant at 5 % level.

The results were on the whole similar for the annually, biennially and triannually harvested plots. No significant variation was found to be due to the plots or the subdivisions within each plot, indicating that conditions within each plot and subplot were similar, such as the total surface area available for moss growth, moisture (partly) and temperature conditions, etc. However, very significant differences were found to be caused by the annual treatment, which were most likely due to variations in the way of harvesting of moss from year to year. For instance during 1972 the moss was harvested from the majority of trees within the plots. In 1973, however, many of the trees had moss of only very short length

(5 mm or less) which could not be harvested in standard fashion and was thus left until 1974 when it might be long enough for plucking.

Some influence is obviously due to the variation in the number of misty days per annum at Woodbush, as it has been shown that mist contributes significantly to the amount of moisture available to mosses.

It is interesting to note that increases or decreases in moisture and "treatment" do not seem to affect all plots to the same degree. Table 10 reflects the proportions of moss collected from each plot in 1972, 1973, 1974 and 1975 respectively considering plot C as unit. It will be noted that plot B produced 2,6 times as much in 1972, 2,3 times as much in 1973, 2,9 times as much in 1974 and only 1,0 times as much in 1975. This variation is also apparent in the other plots such as A where the production went from 1,9 times that of C in 1972 to 5,1 times as much in 1973 and dropped to 3,3 times in 1974 while it was only 1,3 times in 1975. It could here be noted that plot A is probably the most favourably situated plot of the set with regard to moisture and other aspects and therefore consistently shows a higher growth rate. Plot D situated in the most xeric situation also shows similar trends.

TABLE 10.

Comparison of proportions of moss produced from each plot during successive years. Plot C taken as unit in all cases.

Plot	1972	1973	1974	1975
A	1,9	5,1	3,4	1,3
B	2,6	2,3	2,9	1,0
C	1,0	1,0	1,0	1,0
D	1,2	0,0	1,4	0,7

DISCUSSION AND CONCLUSION

The average annual growth of moss at Woodbush over the three years 1973, 1974 and 1975 is 47 grams per plot while that at Bloemfontein is 45 grams indicating that in spite of the differences in rainfall, climate and edaphic conditions, similar growth is achieved. This lends support to the view that mist is an important factor for the growth of moss. The average regrowth is 7,64 % per annum. The biennial plots show a regrowth of 15,45 % over the two periods which is slightly more than double that of the annually harvested plots. The triannually harvested plots produced 27,58 % of the initial harvest after three years which is slightly more than three and a half times as much as the annually harvested plots and about 1,75 times as much as the biennially harvested ones. The growth rate appears to accelerate over three years as an average rate of 8,99 % is achieved. It is difficult at this stage to extrapolate the further rate of growth but it is assumed that this rate will probably not be maintained. At the present rate it will take the moss a minimum of seven years and possibly as much as 10 years to regenerate fully. It is not known at what stage moss actually reaches maturity and when it would be

most productive to harvest. It may be that the moss after reaching a certain length slows down completely so that harvesting on a sustained yield basis may best be done at an earlier stage when the standing crop has reached optimum growth and will begin to slow down. This stage may already be reached at seven years after harvesting. It must, however, be emphasised once again that harvesting during the experiment was considerably more severe than that of the Bantu gatherers who take only what is readily available, leaving ample moss and thus probably speeding up the process of regeneration.

Based on the average amount of moss initially harvested from the plots, 340 kg could be harvested per hectare which when calculated to cover the 15 958,83 hectares amounts to an overall weight of 5 426 002 kg of moss. In order to manage the reaping of moss on a sustained yield basis over a period of seven years 2 279,83 hectares could be harvested giving 775 143 kg of moss per year. On a 10 year rotational basis 1 595,88 hectares could be harvested giving a sustained yield of 542 600 kg per year. While the present experiment only sampled the moss growing on the trees itself, mention should be made of the large amounts also found hanging from the branches of smaller trees, on dead logs and on rocks which contribute considerably to the standing crop of a hectare of forest. This is, however, not uniform and some patches of forest are devoid of this. In addition it appears that once the moss has been removed from dead or decaying wood no subsequent regrowth occurs apart from that left from the previous plucking. There is, therefore, at least initially considerably more moss than the above figures indicate. In conclusion it may be worthwhile to harvest a set of plots after a period of five years and again after seven years, which will then give a good indication of the rate of growth during these periods as well as determine the best time interval between harvesting. The moss itself, however, limits the interval between harvests and is, therefore, the main limiting factor.

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TABLE 2.
Weights of moss per unit surface area from plots at woodbush

Plot No.	Wt. of moss per plot (kg)					No. of trees				Bole surface area (sq. m)				Wt. of moss/unit surface area in kg/sq. m				
	1970	1972	1973	1974	1975	1972	1973	1974	1975	1972	1973	1974	1975	1970	1972	1973	1974	1975
A	2.481	0.350	0.075	0.105	0.055	23	17	12	12	24.84	24.50	22.79	15.38	0.095	0.014	0.003	0.005	0.004
B	1.758	0.490	0.034	0.090	0.042	30	13	22	14	21.13	20.19	30.84	20.00	0.054	0.015	0.001	0.003	0.002
C	0.487	0.190	0.014	0.031	0.042	30	9	18	15	19.14	6.33	11.31	10.78	0.025	0.009	0.002	0.003	0.004
D	0.927	0.220	0.000	0.046	0.029	17	—	9	9	14.08	0.00	10.22	7.88	0.065	0.015	0.000	0.004	0.004
Ave.	1.339	0.313	0.031	0.068	0.042					22.55	12.76	18.79	13.49	0.059	0.013	0.001	0.004	0.003

TABLE 3.
Weights of moss per unit surface area from plots at Bloeufontein

Plot No.	Wt. of moss per plot (kg)					No. of trees				Bole surface area (sq. m)					Wt. of moss/unit surface area in kg/sq. m				
	1970	1972	1973	1974	1975	1972	1973	1974	1975	1972	1973	1974	1975	1971	1972	1973	1974	1975	
A	0.415	1.250	0.042	0.160	0.170	25	15	21	16	29.17	24.73	28.16	15.59	0.014	0.043	0.001	0.006	0.010	
B	0.284	0.430	0.006	0.035	0.020	27	1	21	11	22.53	1.80	19.54	9.57	0.013	0.019	0.003	0.002	0.002	
C	0.139	0.570	0.000	0.073	0.041	35	0	10	8	24.38	0.00	11.40	7.31	0.007	0.023	0.000	0.006	0.006	
D	0.307	0.220	0.004	—	—	23	1	—	—	17.08	2.40	0.00	8.24	0.019	0.013	0.001	0.000	0.002	
E	0.193	0.080	0.000	0.000	0.020	17	0	0	6	15.83	0.00	0.00	8.24	0.014	0.006	0.000	0.000	0.002	
Ave.	0.268	0.510	0.010	0.067	0.063					21.79	5.79	14.78	10.18	0.013	0.021	0.001	0.003	0.005	

TABLE 4a.
Variations in weight of moss per unit surface area (kg/sq. m) within plots at Woodbush over the period July 1972—July 1975

Plot No.	Bole surface area (sq. m)				Annual plots								Wt. of moss/unit surface area in (kg/sq. m)							
					Wt. of moss (kg)				Number of trees											
	1972	1973	1974	1975	1972	1973	1974	1975	1972	1973	1974	1972	Ave.	1973	Ave.	1974	Ave.	1975	Ave.	
A(a)	6.67	6.61	5.65	3.36	0.074	0.019	0.034	0.009	6	5	4	0.011	0.012	0.003	0.004	0.006	0.005	0.003	0.004	
(b)	1.65	1.03	1.20	0.93	0.019	0.003	0.006	0.004	4	2	3	0.011		0.003		0.004				
(c)	12.86	13.09	12.38	9.21	0.215	0.031	0.046	0.025	10	8	7	0.016		0.002		0.004				
(d)	3.66	3.77	3.56	1.78	0.041	0.023	0.019	0.018	4	4	3	0.011		0.006		0.005				
B(a)	7.53	3.95	6.36	2.34	0.101	0.009	0.020	0.009	6	1	2	0.013	0.014	0.002	0.0015	0.003	0.003	0.004	0.002	
(b)	6.23	4.19	6.49	4.90	0.062	0.009	0.023	0.007	6	4	6	0.009		0.002		0.003				
(c)	8.43	5.55	8.66	7.52	0.101	0.007	0.025	0.012	7	4	6	0.012		0.001		0.003				
(d)	9.94	6.50	9.32	6.14	0.223	0.010	0.023	0.013	12	4	8	0.022		0.001		0.002				
C(a)	4.29	2.71	3.94	3.92	0.081	0.005	0.014	0.014	8	3	6	0.019	0.011	0.002	0.0015	0.003	0.002	0.004	0.004	
(b)	2.65	0.00	2.08	2.41	0.081	0.000	0.003	0.003	3	—	2	0.006		0.000		0.001				
(c)	9.03	2.20	2.78	2.53	0.051	0.008	0.010	0.011	11	3	5	0.006		0.003		0.003				
(d)	3.17	1.42	2.51	1.92	0.038	0.002	0.005	0.013	8	3	6	0.012		0.001		0.002				
D(a)	0.72	0.00	1.46	0.80	0.009	0.000	0.010	0.001	3	—	3	0.013	0.014	—	—	0.007	0.004	0.002	0.004	
(b)	3.76	0.00	0.81	1.64	0.048	0.000	0.002	0.006	6	—	1	0.013		—		0.002				
(c)	3.17	0.00	3.73		0.032	0.000	0.009		3	—	3	0.010		—		0.002				
(d)	6.43	0.00	4.21		0.135	0.000	0.025		5	—	2	0.021		—		0.006				

TABLE 4b.
Variations in weight of moss per unit surface area (kg/sq. m) within plots at Woodbush over the period July 1972—July 1974—Biennial plots

Plot No.	Bole surface area (sq. m)		Wt. of moss (kg)		Number of trees		Wt. of moss/unit surface area in kg/sq. m			
	1972	1974	1972	1974	1972	1974	1972	1974	Average	
									1972	1974
A1(a)	6.91	5.77	0.228	0.024	8	3	0.033	0.004	0.03	0.004
(b)	9.83	4.94	0.470	0.021	7	3	0.048	0.004		
(c)	10.36	9.98	0.213	0.041	10	8	0.021	0.004		
(d)	3.89	3.17	0.115	0.008	9	5	0.029	0.003		
B1(a)	21.76	19.94	0.444	0.050	27	18	0.020	0.002	0.01	0.002
(b)	0.69	—	0.004	—	3	—	0.006	—		
(c)	5.82	0.48	0.072	0.002	5	1	0.012	0.004		
(d)	4.60	1.44	0.043	0.003	9	2	0.009	0.002		
C1(a)	6.23	6.12	0.192	0.040	6	5	0.031	0.006	0.03	0.007
(b)	3.76	2.89	0.117	0.029	9	5	0.031	0.010		
(c)	2.28	1.69	0.067	0.007	6	3	0.029	0.004		
(d)	1.75	0.94	0.039	0.005	7	3	0.023	0.005		
E1(a)	3.81	1.27	0.097	0.005	8	2	0.025	0.004	0.03	0.004
(b)	7.93	5.33	0.178	0.021	12	3	0.022	0.004		
(c)	4.58	2.62	0.082	0.006	8	4	0.018	0.002		
(d)	4.72	3.07	0.196	0.017	4	2	0.042	0.005		
F1(a)	4.74	3.64	0.153	0.018	8	3	0.032	0.005	0.04	0.005
(b)	1.05	1.13	0.046	0.005	7	3	0.044	0.004		
(c)	6.56	4.08	0.233	0.023	13	6	0.036	0.005		
(d)	3.65	3.74	0.170	0.023	10	4	0.046	0.006		

TABLE 4c.
Variations in weight of moss per unit surface area (kg/sq. m) within plots at woodbush over the period July 1972—July 1975—Tri-annual plots

Plot No.	Bole surface area (sq. m)		Wt. of moss (kg)		Number of trees		Wt. of moss/unit surface area in kg/sq. m			
	1962	1975	1972	1975	1972	1975	1972	1975	Average	
									1972	1975
A2(a)	5,91	3,43	0,164	0,026	8	5	0,028	0,007	0,026	0,006
(b)	3,14	2,63	0,056	0,017	4	2	0,018	0,006		
(c)	6,47	6,10	0,202	0,029	10	8	0,031	0,005		
(d)	5,27	1,86	0,113	0,017	8	5	0,021	0,009		
B2(a)	6,81	5,13	0,096	0,022	13	7	0,014	0,004	0,023	0,005
(b)	7,11	4,25	0,172	0,011	16	5	0,024	0,003		
(c)	0,66	4,70	0,003	0,033	3	3	0,005	0,007		
(d)	5,27	0,67	0,189	0,012	6	2	0,035	0,018		
C2(a)	2,05	1,89	0,119	0,029	6	5	0,058	0,160	0,027	0,014
(b)	6,44	5,61	0,052	0,043	8	4	0,008	0,008		
(c)	0,97	0,56	0,150	0,011	3	2	0,015	0,019		
(d)	6,06	5,12	0,238	0,099	4	3	0,039	0,019		
E2(a)	7,72	3,13	0,134	0,019	13	3	0,017	0,006	0,021	0,009
(b)	3,18	2,43	0,172	0,035	4	2	0,054	0,014		
(c)	0,21	—	0,000	0,000	1	—	—	—		
(d)	6,98	1,87	0,068	0,013	7	2	0,009	0,007		
F2(a)	2,27	2,51	0,161	0,017	7	6	0,071	0,007	0,053	0,006
(b)	1,25	3,69	0,092	0,030	7	3	0,074	0,008		
(c)	4,63	1,35	0,316	0,006	3	1	0,068	0,004		
(d)	10,11	7,08	0,399	0,037	18	7	0,039	0,005		

TABLE 6.
Rainfall in millimetres over the past seven years for experimental areas Broederstroom

Month	1969	1970	1971	1972	1973	1974	1975	Average
January	362,3	129,4	428,1	860,8	121,8	620,9	314,9	405,5
February	125,3	122,1	209,9	639,5	182,0	700,0	599,5	368,3
March	434,3	31,7	42,5	519,8	228,3	256,6	204,1	245,3
April	104,0	24,1	152,8	78,5	233,6	143,1	127,5	123,4
May	42,4	64,0	33,8	72,1	6,6	6,3	33,0	36,9
June	16,0	19,0	7,5	6,5	40,1	0,0	41,5	18,7
July	3,0	45,5	0,0	18,0	38,8	37,5	1,5	20,6
August	12,5	8,3	4,7	14,0	11,0	8,5	31,0	12,9
September	42,5	36,1	40,0	14,6	152,5	97,0	20,5	57,6
October	228,3	96,3	177,8	110,2	206,9	52,6	37,3	129,9
November	75,6	93,0	228,5	139,8	164,5	231,5	97,0	147,1
December	188,4	225,3	175,3	223,6	554,2	205,0	407,6	282,7
Total	1624,8	894,8	1500,9	2697,4	1940,0	2359,0	1915,4	1848,9

TABLE 6.
Rainfall in millimetres over the past seven years for experimental areas Louis Trichardt

Month	1969	1970	1971	1972	1973	1974	1975	Average
January	51,2	0,0	181,1	193,3	72,3	259,7	165,8	131,9
February	57,9	89,6	30,9	154,9	103,0	259,5	248,3	134,9
March	248,6	23,7	24,8	135,8	62,4	15,1	58,2	81,2
April	31,7	0,0	45,1	12,0	58,0	51,5	69,4	38,2
May	19,7	13,5	43,5	32,9	3,5	38,6	29,2	25,8
June	4,9	16,5	4,1	2,0	15,2	0,0	19,8	8,9
July	0,0	7,0	0,0	0,0	16,7	8,1	0,0	4,5
August	0,0	0,0	0,0	6,2	0,0	0,0	5,5	1,7
September	44,4	3,9	15,6	2,0	144,2	78,6	0,0	41,2
October	57,6	59,6	85,5	173,7	113,6	2,3	11,5	71,9
November	37,5	45,3	207,1	105,4	43,8	165,4	67,0	95,9
December	115,9	167,0	60,3	41,2	147,9	92,6	132,6	108,2
Total	669,4	426,2	689,0	859,4	780,6	919,9	807,3	744,3